2021 DSCOVR Science Team Meeting

Unique Observational Constraints on the Seasonal and Longitudinal Variability of Earth's Planetary Albedo and Cloud Distribution Inferred from EPIC Measurements
(Part 1)

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Conclusions

1. NASA's DSCOVR Mission *EPIC and NISTAR data provide new and unique diagnostic perspective* for assessing global climate model performance.

2. *NISTAR data are unique for NIR/SW spectral ratio diagnostic capability* to assess global climate model radiative transfer spectral treatment.

3. *EPIC climate-style planetary albedo diagnostics* show GISS ModelE2 overestimates clouds over oceans, underestimates clouds over land.

4. *EPIC Hovmoller maps provide a La Nina activity detection capability* based on planetary albedo space-time variability.

5. Zonal dependence can, *and should be*, implemented in longitudinal slicing.
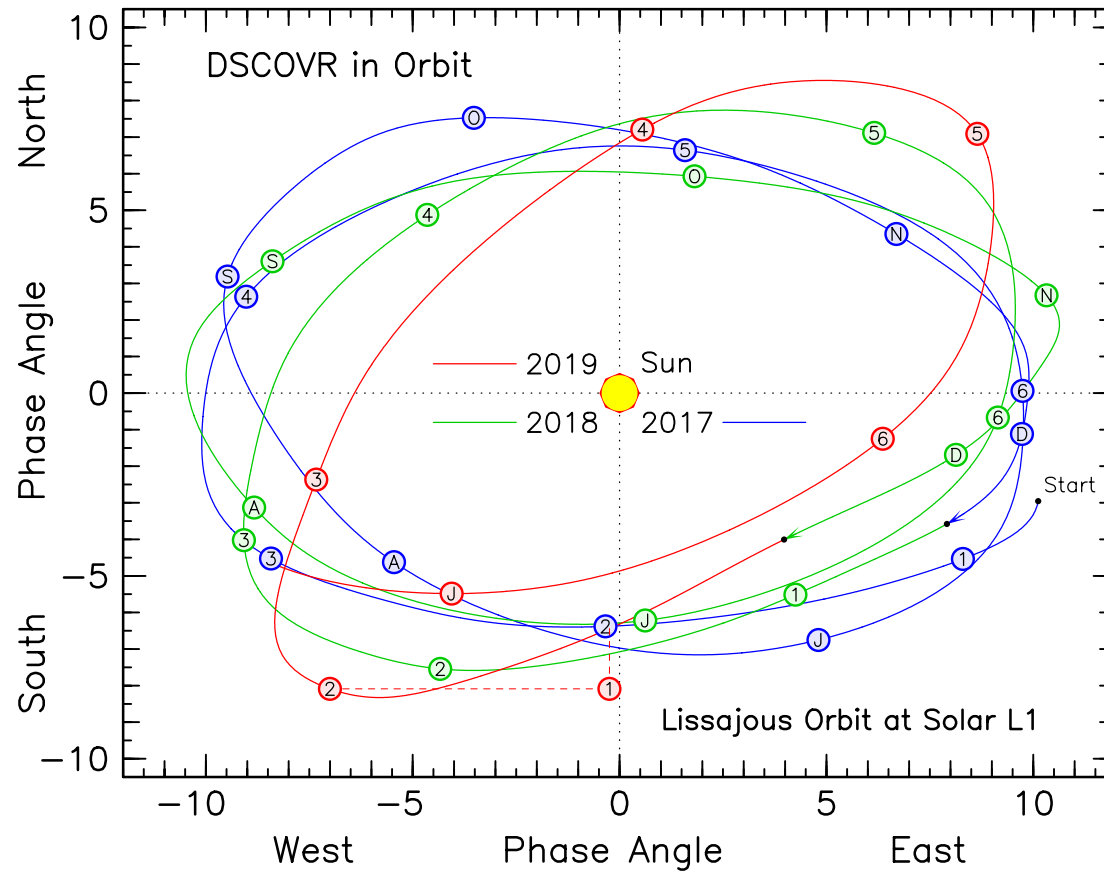
NISTAR Measurements *vs* ModelE2.1 Vis/NIR Results
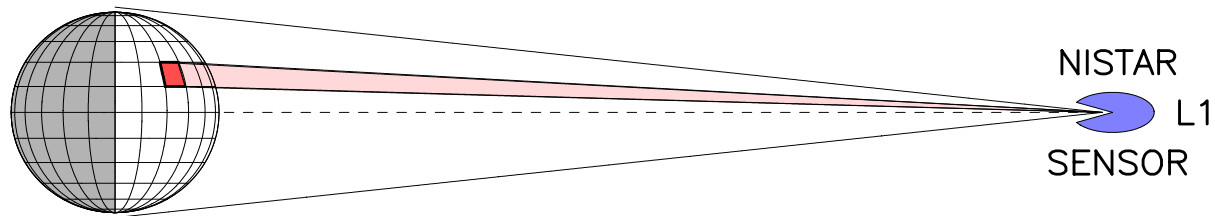
Band-A

(0.2 – 100μm)

TOR (SW+LW)

Band-B

(0.2 – 4.0μm)

RSR (Vis)

Band-C

(0.7 – 4.0μm)

near-IR

Band-D (diode**)**

(0.3 – 1.1μm)

Vis (cal)

Active   Cavity   Radiometers   **Photodiode**

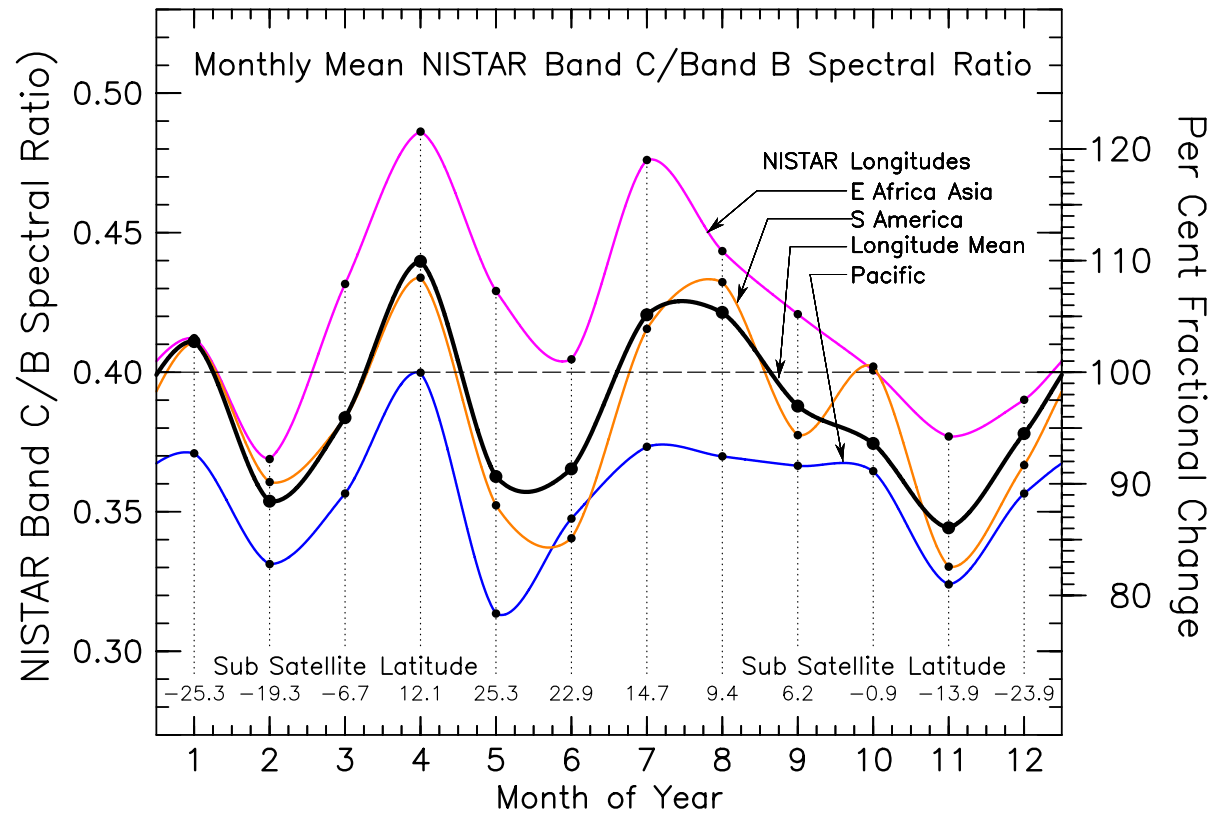# NISTAR & EPIC in Lissajous Orbit around the Lagrangian L1 Point

NISTAR Bands-C/B $(0.7 - 4.0\mu m)/(0.2 - 4.0\mu m)$ NIR/SW Spectral Ratio

Seasonal spaghetti map of NISTAR Band-C / Band-B spectral ratio of the NIR/SW radiance reflected from the dayside hemisphere for selected longitudes of noon-time Sun. Solid black curve is daily average over all longitudes.

NISTAR Bands-C/B $(0.7 - 4.0\mu m)/(0.2 - 4.0\mu m)$ NIR/SW Spectral Ratio
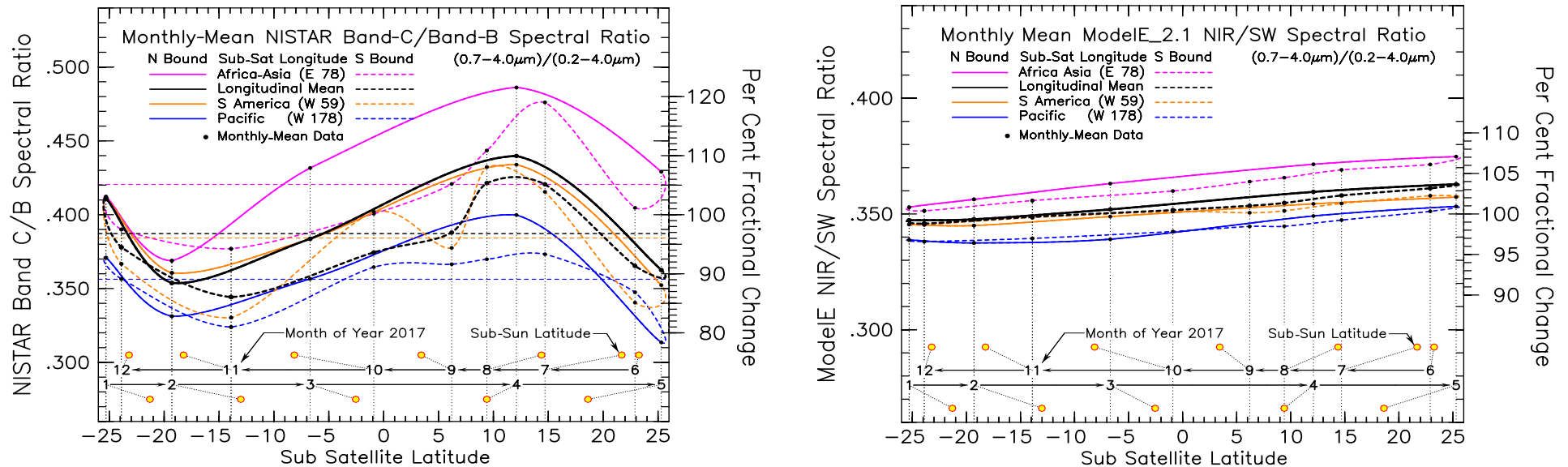
Pinwheel-format diagram of longitudinally sliced NISTAR Band-C $(0.7 - 4\ \mu m)$/Band-B $(0.2 - 4\ \mu m)$ NIR/SW spectral ratio for year 2017 **(Left)**, plotted as a function of the DSCOVR sub-satellite latitude. At figure bottom are mid-month positions of the DSCOVR spacecraft sub-satellite location (numbers identify month of year). Corresponding sub-solar latitude (declination) is denoted by the yellow circles. **(Right)** corresponding NIR/SW spectral ratio results from GISS ModelE2 with output data sampled in accord with the DSCOVR Satellite Ephemeris viewing geometry.

Common Format Model/Data Comparisons

2
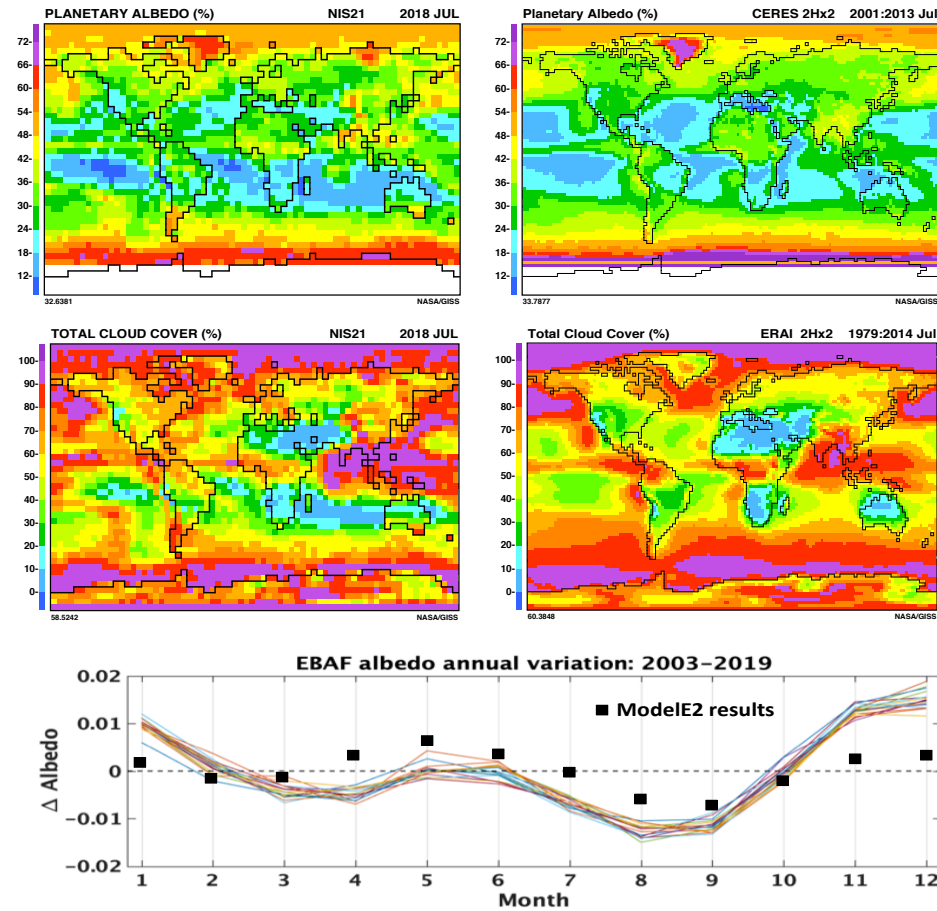
EPIC / NISTAR Perspective on SW Flux Determination

a) side view

Moon

Θ_1 Θ_2 Θ_3

Earth

E

Eq

ϕ_D

DSCOVR

b) disc views

A_d A_v A_h

DSCOVR view
L1

unviewed
L2
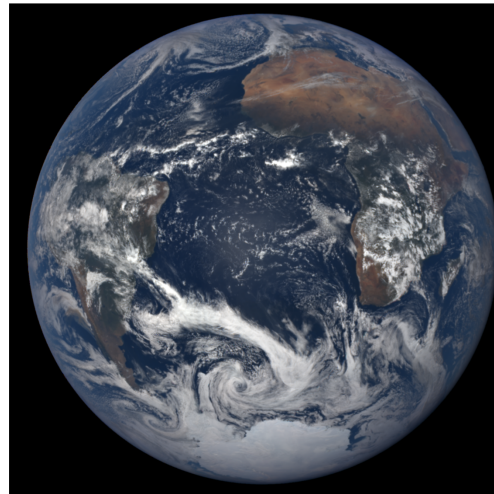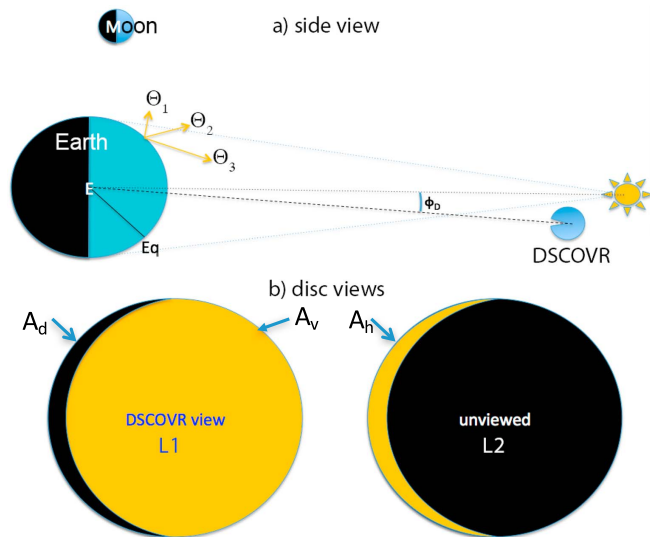
Epic 1/26/17
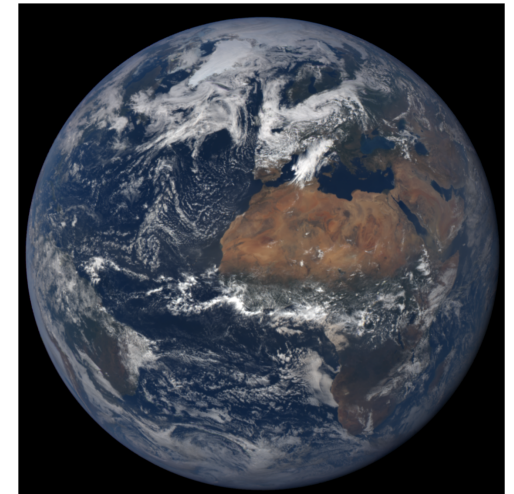
Epic 6/30/17

EPIC and NISTAR viewing geometry from the Lissajous orbit around the Lagrangian L1 point in the direction of the Sun. Left panel (Fig. 1 of Su et al., 2018) depicts the EPIC/NISTAR viewing aspects. Right panels depict sample near-hourly images of Earth (https://www.epic.gsfc.nasa.gov) from which detailed sunlit hemisphere climate data can be derived. Note that in orbiting the Lagrangian L1 point, EPIC and NISTAR view 92-97% of the sunlit hemisphere, never 100%. *The unique space-time sampling and precise longitudinal slicing make EPIC data ideally suited for climate-relevant data acquisition.* **But, this requires the same EPIC/NISTAR-view space-time sampling for climate GCM output data.**

EPIC-Derived: 2018 All-cloud (EPIC images available per day/month)

DayMon	Jan=1	Feb=2	Mar=3	Apr=4	May=5	Jun=6	Jul=7	Aug=8	Sep=9	Oct=10	Nov=11	Dec=12	Annual
1	12	13	13	13	22	13	22	0	22	13	13	13	169
2	10	6	0	10	21	22	22	21	22	13	13	13	173
3	13	15	13	10	22	22	22	22	13	11	13	13	189
4	12	11	13	3	22	22	22	22	9	12	13	13	174
5	11	9	13	10	22	19	22	22	12	5	13	13	171
6	13	13	13	10	22	21	19	22	13	12	13	13	184
7	13	13	12	10	22	22	22	22	13	13	13	11	186
8	13	13	10	10	22	18	22	20	13	11	13	13	178
9	13	12	10	10	22	0	22	22	13	9	11	13	157
10	13	13	13	11	22	0	22	22	13	13	13	12	167
11	13	13	13	13	21	6	22	22	12	13	13	13	174
12	13	13	9	13	22	22	22	22	13	11	13	13	186
13	13	13	13	13	22	22	22	22	13	12	13	12	190
14	12	13	13	13	21	22	22	22	11	13	10	13	185
15	0	13	13	13	22	22	21	8	13	4	13	13	155
16	13	13	13	9	22	22	22	0	13	12	13	13	165
17	13	13	13	12	22	22	22	19	13	12	12	8	181
18	13	13	13	13	22	22	22	11	10	4	13	13	169
19	13	13	13	12	21	22	20	17	13	12	13	13	182
20	12	13	13	11	21	22	18	22	13	3	12	13	173
21	13	13	12	13	11	22	21	22	13	2	13	13	168
22	13	13	0	13	16	19	22	22	13	13	13	13	170
23	12	13	13	13	22	22	20	22	13	4	13	13	180
24	13	13	13	12	22	22	22	22	6	0	12	13	170
25	13	13	12	22	18	14	22	22	13	0	13	11	173
26	13	13	13	22	22	21	22	22	11	13	13	13	198
27	13	12	12	19	22	22	0	22	13	13	10	13	171
28	13	13	13	22	22	22	22	17	13	13	12	13	195
29	13	0	13	22	22	21	22	16	13	13	9	13	177
30	13	0	11	0	21	20	15	21	13	13	13	13	153
31	0	0	13	0	6	0	21	22	0	13	0	13	88
Sum Mnthly	367	351	361	377	639	568	639	590	388	305	374	392	5351

EPIC-Derived: 2018 All-cloud (EPIC data points per UT longitude/month)

EPIC-2018   Longitudinal and Seasonal Variability: All-Cloud   Number UThr Interpolated Points /Month

hourUT	Jan=1	Feb=2	Mar=3	Apr=4	May=5	Jun=6	Jul=7	Aug=8	Sep=9	Oct=10	Nov=11	Dec=12	Annual
0	25	24	24	24	29	25	29	28	26	20	24	27	305
1	29	27	28	28	29	27	30	28	30	23	29	31	339
2	29	27	28	28	29	27	30	29	30	24	30	31	342
3	29	27	28	28	29	27	30	29	30	25	30	31	343
4	29	27	29	28	30	27	30	29	30	24	30	31	344
5	29	27	29	28	30	27	30	29	30	25	30	31	345
6	29	27	29	28	30	27	30	29	30	26	30	31	346
7	29	27	29	28	30	27	30	29	30	23	30	31	343
8	29	27	29	28	30	27	30	29	30	25	30	31	345
9	29	27	29	28	30	27	30	29	30	24	30	31	344
10	29	27	29	28	30	27	30	28	30	23	30	31	342
11	29	27	29	28	30	27	30	28	30	24	30	31	343
12	29	27	29	28	30	27	30	28	30	24	30	31	343
13	29	27	29	28	31	28	30	27	30	23	30	31	343
14	29	28	29	28	31	28	30	27	30	24	30	30	344
15	29	28	29	29	31	28	30	27	30	23	30	30	344
16	29	27	28	27	31	27	30	27	29	22	30	30	337
17	29	27	28	27	30	27	29	27	29	23	30	30	336
18	28	27	28	23	30	27	29	27	28	23	29	30	329
19	28	27	27	20	30	27	29	27	28	22	29	30	324
20	28	27	27	20	30	26	29	27	28	23	29	30	324
21	28	26	27	19	30	26	29	26	28	23	28	30	320
22	27	26	25	19	29	25	28	26	28	22	28	30	313
23	19	19	17	16	29	25	27	26	22	16	21	22	259
Global	676	637	663	616	718	643	709	666	696	554	697	722	7997

EPIC-Derived: 2018 All-cloud Sky Fraction (percent)

EPIC-2018   Longitudinal and Seasonal Variability: All-Cloud   EPIC Sky-view Cloud Fraction (PerCent)

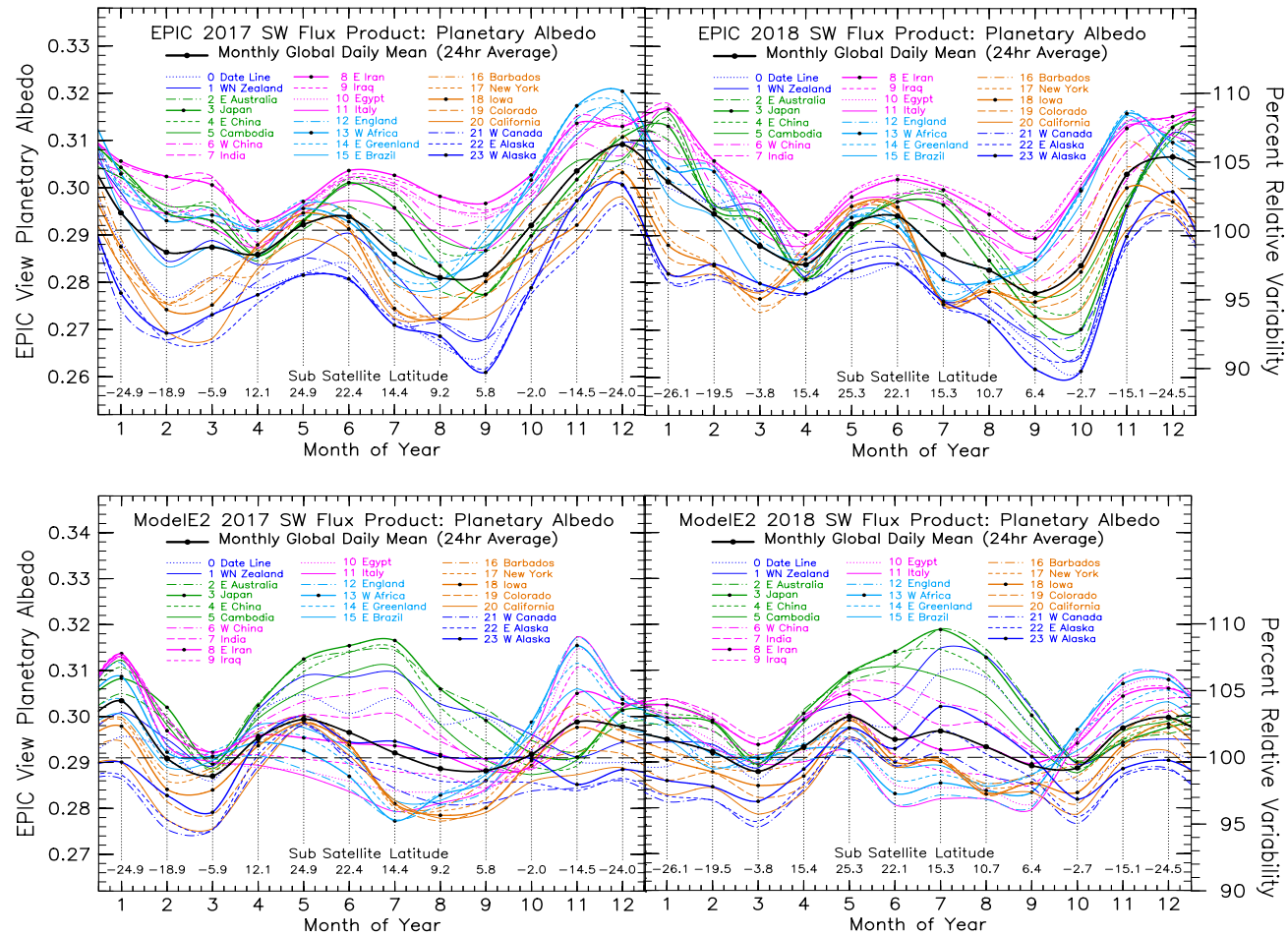| hourUT	Jan=1	Feb=2	Mar=3	Apr=4	May=5	Jun=6	Jul=7	Aug=8	Sep=9	Oct=10	Nov=11	Dec=12	Annual
0	68.10	68.40	66.10	62.06	62.96	64.51	65.35	65.36	63.80	63.16	66.06	68.30	65.33
1	68.00	67.69	65.80	62.13	62.89	64.51	65.45	65.33	63.44	62.49	65.85	68.20	65.14
2	67.82	66.60	65.03	62.10	62.91	64.59	65.79	64.86	62.53	61.94	65.57	67.78	64.79
3	67.15	65.67	63.96	61.66	62.78	64.50	65.76	63.49	61.37	61.50	64.52	66.79	64.09
4	66.13	64.87	63.03	60.83	61.98	63.73	64.79	62.02	60.28	60.80	62.95	65.38	63.06
5	64.90	63.92	61.87	59.74	60.84	62.26	63.18	60.96	59.67	59.76	61.69	64.10	61.90
6	63.32	62.56	60.37	58.69	59.67	60.59	61.51	60.28	59.13	58.75	60.61	62.86	60.69
7	60.85	60.63	58.86	57.83	59.00	59.89	60.63	59.86	58.82	58.57	59.78	61.19	59.66
8	58.76	59.42	58.01	57.44	58.66	59.60	60.05	59.58	58.81	58.84	59.36	59.72	59.02
9	58.10	59.65	58.45	57.97	58.84	59.39	59.70	59.38	59.07	59.65	59.87	58.97	59.08
10	58.08	59.97	58.73	58.18	58.93	59.04	59.28	58.55	58.72	60.11	60.31	58.61	59.03
11	58.35	60.26	58.30	57.63	58.63	58.11	58.18	56.92	57.75	60.31	60.56	58.65	58.63
12	58.76	60.47	57.83	56.71	57.87	56.99	56.65	55.87	57.42	60.28	60.85	58.78	58.19
13	59.29	60.76	57.61	55.99	56.93	55.81	55.12	55.81	57.79	60.94	61.46	59.06	58.03
14	59.82	61.45	58.37	56.64	57.49	55.99	55.00	57.72	59.52	62.36	62.81	59.80	58.90
15	60.17	62.03	59.51	57.78	58.96	57.38	56.96	60.23	61.48	63.80	64.22	60.70	60.25
16	60.30	62.40	60.35	58.97	60.47	59.61	58.92	61.82	62.63	64.83	65.39	61.91	61.46
17	60.62	62.87	61.28	60.22	61.73	61.41	60.60	62.89	63.50	65.67	66.41	63.08	62.52
18	61.73	64.03	62.92	61.69	62.86	62.80	62.21	63.78	64.23	66.24	67.29	64.30	63.67
19	63.09	65.16	64.36	63.18	64.02	63.85	63.81	64.49	64.87	66.50	67.86	65.38	64.71
20	64.18	65.92	65.03	63.93	65.21	64.99	64.98	65.02	65.12	66.12	67.47	65.82	65.31
21	64.71	66.41	65.15	63.66	65.49	65.68	65.59	65.61	65.02	65.61	66.75	65.87	65.46
22	65.11	66.77	65.04	62.73	64.64	65.83	65.68	65.41	64.57	64.83	66.01	65.87	65.20
23	65.02	66.99	64.77	62.06	63.66	65.16	65.18	65.09	64.37	64.54	65.70	65.97	64.86
Global	62.60	63.54	61.70	59.99	61.14	61.51	61.68	61.68	61.41	62.40	63.72	63.21	62.04

EPIC-Derived: 2018 All-cloud Sky Fraction (std dev)

EPIC-2018   Longitudinal and Seasonal Variability: All-Cloud   EPIC Cloud Fraction (UTMon Pt Std Dev)

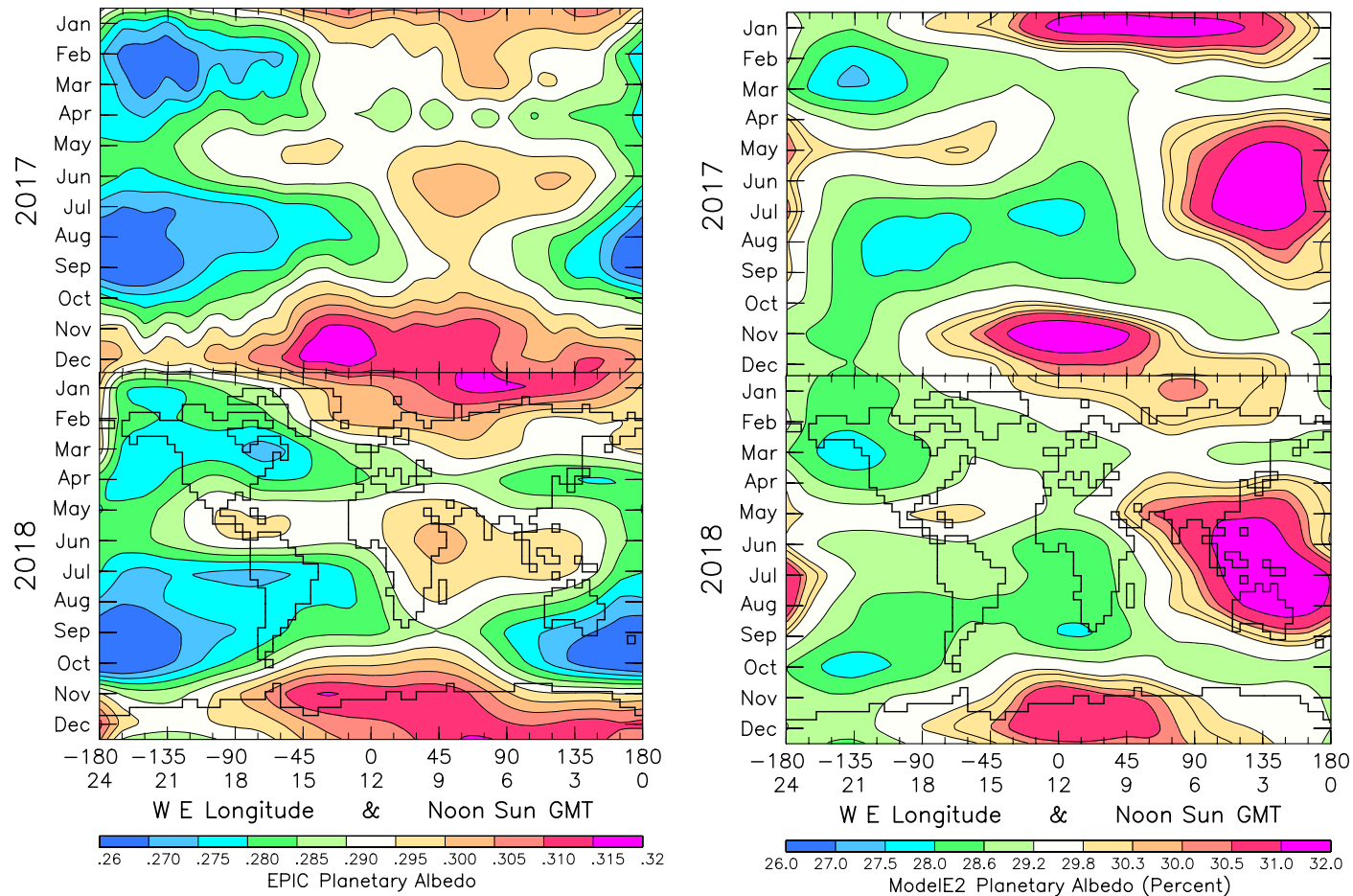| hourUT	Jan=1	Feb=2	Mar=3	Apr=4	May=5	Jun=6	Jul=7	Aug=8	Sep=9	Oct=10	Nov=11	Dec=12	Annual
0	0.37	0.31	0.39	0.29	0.25	0.28	0.23	0.24	0.24	0.49	0.36	0.48	0.33
1	0.31	0.29	0.36	0.26	0.24	0.26	0.23	0.17	0.21	0.60	0.33	0.40	0.31
2	0.27	0.30	0.37	0.27	0.24	0.28	0.22	0.17	0.21	0.87	0.33	0.39	0.33
3	0.24	0.29	0.36	0.26	0.27	0.28	0.24	0.18	0.19	0.50	0.29	0.38	0.29
4	0.24	0.27	0.33	0.24	0.26	0.27	0.24	0.17	0.18	0.37	0.25	0.35	0.26
5	0.27	0.27	0.29	0.25	0.24	0.24	0.21	0.17	0.18	0.35	0.20	0.31	0.25
6	0.29	0.31	0.26	0.28	0.26	0.25	0.19	0.19	0.22	0.31	0.22	0.30	0.26
7	0.23	0.32	0.28	0.28	0.25	0.22	0.23	0.18	0.24	0.24	0.26	0.28	0.25
8	0.21	0.31	0.27	0.27	0.24	0.23	0.25	0.19	0.25	0.21	0.30	0.26	0.25
9	0.19	0.29	0.26	0.28	0.22	0.25	0.23	0.18	0.22	0.20	0.29	0.30	0.24
10	0.18	0.25	0.27	0.31	0.20	0.23	0.19	0.22	0.21	0.24	0.27	0.35	0.24
11	0.16	0.20	0.19	0.30	0.20	0.22	0.17	0.23	0.23	0.28	0.23	0.36	0.23
12	0.16	0.18	0.16	0.33	0.21	0.22	0.20	0.23	0.27	0.30	0.21	0.33	0.23
13	0.19	0.24	0.18	0.35	0.21	0.25	0.20	0.21	0.32	0.33	0.26	0.31	0.25
14	0.18	0.27	0.21	0.32	0.22	0.26	0.16	0.22	0.30	0.32	0.25	0.29	0.25
15	0.20	0.30	0.28	0.27	0.23	0.28	0.17	0.19	0.30	0.32	0.23	0.28	0.25
16	0.19	0.30	0.27	0.25	0.25	0.30	0.19	0.19	0.35	0.34	0.19	0.24	0.25
17	0.19	0.29	0.28	0.23	0.24	0.33	0.20	0.22	0.38	0.33	0.19	0.23	0.26
18	0.20	0.32	0.27	0.22	0.23	0.36	0.18	0.27	0.37	0.31	0.25	0.24	0.27
19	0.22	0.36	0.27	0.24	0.22	0.34	0.20	0.29	0.36	0.32	0.30	0.26	0.28
20	0.26	0.37	0.28	0.26	0.22	0.31	0.18	0.27	0.36	0.31	0.25	0.30	0.28
21	0.29	0.35	0.28	0.25	0.23	0.30	0.20	0.26	0.32	0.34	0.23	0.36	0.29
22	0.34	0.34	0.31	0.23	0.25	0.31	0.22	0.23	0.27	0.39	0.23	0.41	0.29
23	0.42	0.45	0.41	0.30	0.25	0.29	0.24	0.28	0.30	0.52	0.26	0.49	0.35
Global	0.24	0.30	0.29	0.27	0.23	0.27	0.21	0.21	0.27	0.37	0.26	0.33	0.27

Longitudinally Sampled Planetary Albedo: EPIC *vs* ModelE2

Hovmoller Contour Map of Planetary Albedo: EPIC *vs* ModelE2

EPIC Planetary Albedo

.26 .270 .275 .280 .285 .290 .295 .300 .305 .310 .315 .32

ModelE2 Planetary Albedo (Percent)

26.0 27.0 27.5 28.0 28.6 29.2 29.8 30.3 30.0 30.5 31.0 32.0

W E Longitude & Noon Sun GMT

Hovmoller Ratio Map of Planetary Albedo: EPIC *vs* ModelE2

EPIC Planetary Albedo (Percent Change)

ModelE2 Planetary Albedo (Percent Change)